

Historic, Archive Document

Do not assume content reflects current scientific knowledge, policies, or practices.

Agricultural Research

1.98
Ag 84 cz

~~PRR~~

**Printer's Ink:
Growing Our Own**

Story on Page 10



From Plastics to Salad Oil—Soybeans Do It All

When most people think of agriculture, they picture apple orchards and berry patches, fields of corn and wheat, vegetables ripening in the sun, and cattle and sheep grazing in the green grass. All of these are a part of U.S. agriculture, but they are far from the whole picture.

Biodegradable plastics, superabsorbents, oils for paint, lubricants for machinery, permanent press processing for cottons, mosquito repellants, and adhesives for shoe soles and book bindings—these are some of the many nonfood products that come from agricultural crops. A major plus for these products is that they come from renewable resources—crops instead of petroleum derivatives. And the crops are grown in this country, so producing such products means less dependence on costly imports.

Soybeans in particular, a 1.9-billion-bushel crop in this country, pervade our everyday life as an all but invisible part of products, from the foam in fire extinguishers to printing inks. [See “All-Soy Ink Splashes Into Print,” page 10.]

Ink based on a 100-percent soybean oil formulation is one of the newest, and probably destined to be one of the least noticed, nonfood products to come from ARS research. That’s because of what it doesn’t do. Soy-oil ink’s superior penetration into newsprint all but eliminates the well-known black smudges on your fingers from newspaper reading.

About 4 years ago, the American Newspaper Publishers Association (ANPA) asked ARS what it could do about replacing conventional petroleum-based ink with an all soy-oil ink. ANPA was committed to the twin goals of developing an ink whose price would be more stable than the fluctuating cost of oil and an ink mainly made from a renewable resource.

Developing an all soy-oil ink not only solves the newspapers’ immediate problems, it also creates an expanded market for soybeans, enhancing revenues for soybean farmers.

Newspaper ink is far from the only industrial use for soybeans. They are an ingredient in everything from

cardboard, glue, caulking, tires, and plastic to paint. Henry Ford used a soybean-derived plastic for car body parts. In a famous 1940 press conference, Ford showed off a dent-resistant soybean trunk lid by walloping it with an ax. But less expensive petroleum prices in the years after World War II pushed soy plastic car parts out of the market.

The market for soybeans last year was almost \$11 billion at the farm level. About 23 million tons of soybean meal were fed to livestock. More than 565 million bushels were exported in the last market year. For humans, soybeans are a ubiquitous ingredient in foods, running the gamut from baby formula to hot dogs and tofu ice cream to beer, which uses soy meal in the brewing process.

And virtually all of the oil in prepared salad dressings is soy oil. Americans consume more than 6 gallons each of soy oil annually.

ARS scientists are hard at work improving the characteristics that make soybeans so useful. Examples include increasing the shelflife of soy oil, altering the balance of fatty acids in the oil, and breeding soybeans with high protein and high yields, disease resistance, and insect tolerance.

Research on industrial uses is as important as looking into food and feed improvements—not only for soybeans, but for many crops.

Agriculture is a science of renewable resources, plant and animal. The more we can produce from these instead of from finite resources, the better for people and the environment.—**J. Kim Kaplan, ARS.**

Agricultural Research



Cover: Newsprint inks in both black and color formulations can now be made from 100 percent soybean oil. Chemist Sevim Erhan prepares inks for laboratory printing tests. Photo by Keith Weller. (K-3998-5)



Page 4



Page 9



Page 18

4 Scientists Forage for Foreign Nuts

The secret to perfecting the pecan may turn up in Southeast Asia.

6 Meat Inspectors "Just Say No" to Drug Residues

Super-sensitive tests ensure there are no animal medicines in food.

8 From Fiber to Fabric: A Better Blend

A patented process ups cotton's percentage in synthetic blends while increasing consumer comfort.

10 All-Soy Ink Splashes Into Print

Not only can they be made at a lower cost than petroleum-based inks, but soy inks give near-perfect penetration into newsprint.

13 Computer Programs Help the Environment

Garden-variety office computers can take the guesswork out of agricultural decisions.

16 What's New in Oilseeds? Check Out Crambe!

When it comes to profit potential, there's nothing namby-pamby about crambe.

18 Will Soy-Spiked Pellets Please Palates of Succulent Shrimp?

If shrimp don't like their dinner, they'll eat one another. So a better shrimp food would be a boon to aquaculturists.

20 Irrigating Drip by Drip

Some of the finest tomatoes in California are now grown in fields where the watering's done from down below.

22 Agnotes

Glowing Eggs Speed Screening of Lemons
Smaller Cows, More Calves in Florida
New Weed Weapon Possible
Inbreeding May Cause Sheep Losses

Vol. 39, No. 3
March 1991

Editor: Lloyd E. McLaughlin
Associate Editor: Regina A. Wigen
Art Director: William Johnson
Photo Editor: John Kucharski
Associate Photo Editor: Anita Daniels

Reference to commercial products and services is made with the understanding that no discrimination is intended and no endorsement by the U.S. Department of Agriculture is implied.

Agricultural Research is published monthly by the Agricultural Research Service, U.S. Department of Agriculture, Washington, DC 20250-2350.

The Secretary of Agriculture has determined that publication of this periodical is necessary in the transaction of public business required by law.

Information in this magazine is public property and may be reprinted without permission. Non-copyrighted photos are available to mass media in color transparencies or black and white prints. Order by photo number and date of magazine issue.

Subscription requests should be placed with the Superintendent of Documents, Government Printing Office, Washington, DC 20402. Please see back cover for order form.

Address magazine inquiries or comments to: The Editor, Information Staff, Room 316, Bldg. 005,

10300 Baltimore Ave., Beltsville Agricultural Research Center-West, Beltsville, MD 20705. Telephone: (301) 344-3280. When writing to request address changes or deletions, please include a recent address label.

Edward R. Madigan, Secretary
U.S. Department of Agriculture

Charles E. Hess, Assistant Secretary
Science and Education

R.D. Plowman, Administrator
Agricultural Research Service

Robert W. Norton, Director
Information Staff

JERRY A. PAYNE



Scientists Forage for Foreign Nuts

"We were looking for germplasm that would benefit the pecan industry," says Jerry A. Payne.

What were these three strange-looking foreigners doing here in the village? And why were they accompanied by important-looking officials from the Ministry of Forestry? One of the strangers, someone said, had climbed a tree and taken some nuts.

The puzzled villagers of Son La in northwestern Vietnam were forming their first impressions of Agricultural Research Service scientists who were searching out Asian hickories. These three seeming nut fiends were touring Vietnam on the first leg of a journey that would also take them to the People's Republic of China.

"We were looking for germplasm that would benefit the U.S. pecan industry," says Jerry A. Payne, acting director of the ARS Southeastern Fruit and Tree Nut Research Laboratory in Byron, Georgia, and noted scaler of trees.

The other strangers were horticulturists L.J. Grauke, from the ARS pecan research facility at Somerville, Texas, and Bruce W. Wood, a colleague of Payne's at Byron.

Seeds of the Hunan hickory (*Carya hunanensis*), collected by USDA-ARS scientists in China, may offer a bounty of genetic traits to strengthen North American species.

"We need to find a way to put new life into the pecan industry and protect trees from pests and disease," Payne says. Aphids, shuckworms, pecan weevils, stink bugs, root borers, casebearers, and mites can render a pecan crop practically worthless. Insect control alone costs an estimated \$75 million annually. In addition to these insect problems, growers face the threat of pecan scab, root rot, crown gall, kernel diseases, and the plague of alternate-year bearing.

Pecan is the most important of the *Carya* (hickory) species, says Grauke. He is the curator of the National Clonal Germplasm Repository for *Carya* at Somerville where the 14 North American pecans are maintained.

The team brought back two species of hickories from Vietnam and two from China.

"For the first time we will have all six Asian hickories in the United States," Grauke says. USDA's Frank Meyer began collecting Asian hickory germplasm in 1915. French botanists studied Vietnamese hickories back in the 1930's. Now Vietnamese, Chinese, and U.S. scientists are striving to protect dwindling forest reserves.

Very few American scientists have seen the Asian hickory species, especially in their natural habitat. Nor has much been written about them—and most of that is in Chinese, laments Grauke.

This is one of the reasons for gathering germplasm, says Payne. "We want to see if there are genetic traits in these species that may benefit the North American species."

Grauke is hopeful. He already has tiny green shoots peeping through the soil from greenhouse plantings.

These are from seed of *Carya tonkinensis*, picked from trees in the Northwestern Forest Reserve at Son La.

Seedlings can be used to test for disease and insect resistance and to study the evolutionary relationships of the genus.

The team gathered seed and herbarium samples of *Carya sinensis* from the Cuc Phuong National Park in

JERRY A. PAYNE



Research horticulturists L.J. Grauke (left) and Bruce Woods collect soil samples at the Cuc Phuong National Park in Vietnam.

Vietnam. This seed, which appears viable, has also been planted.

"The Vietnamese hadn't heard of *C. poilanei*, the third species we were looking for," Grauke says. "We gave them literature noting historic accounts of the species. They promised to look and send us samples if they found it."

Bruce Wood reports the same response from Chinese officials.

"One species that we went after but didn't find was *C. kweichowensis*, which grows at high elevations in a very remote area of China. However, the Chinese promised to gather germplasm and send it to us," Wood says.

The two species gathered in China are *C. cathayensis* (Chinese hickory) and *C. hunanensis* (Hunan hickory).

The team shipped the Vietnamese material directly from Bangkok to the ARS repository at Brownwood since there is no United States embassy in Vietnam.

Hickory samples from China, on the other hand, will be routed through the Chinese embassy in Beijing.

Vietnamese and Chinese alike grow hickories as food crops and value their medicinal properties. They use oil from the nuts for lighting and cooking. Vietnamese women drink a bitter tea brewed from hickory tree bark to contract the uterus after childbirth. The Chinese steam the nuts with raw ginger, sugar, and orange peels as a cough remedy and analgesic.

To thank their hosts for help in collecting germplasm, Payne, Grauke, and Wood presented their Asian colleagues with germplasm from native U.S. pecans and also

with technical literature.—By **Doris Stanley, ARS.**

Jerry A. Payne and Bruce W. Wood are at the USDA-ARS Southeastern Fruit & Tree Nut Research Laboratory, P.O. Box 87, Byron, GA 31008 (912) 956-5656. L.J. Grauke is with the USDA-ARS Pecan Research Unit, Rte. 2, Box 133, Somerville, TX 77879 (409) 272-1402. ♦

Meat Inspectors "Just Say No" to Drug Residues

New high-tech probes may speed up drug testing of meats and poultry we eat. Called monoclonal antibodies, the probes seek out and bind to residues from a type of drug used to treat farm animals. Ranchers rely on the drugs, known as benzimidazoles, to protect their cattle, sheep, pigs, chickens, and goats from parasitic worms. If unchecked, the worms will damage an animal's lungs, liver, or gastrointestinal tract.

To make sure that these potent medicines don't end up in meat and poultry, USDA's Food Safety and Inspection Service (FSIS) randomly samples slaughterhouse carcasses, looking for benzimidazole residues.

At meatpacking plants around the country, FSIS inspectors collect specimens, then ship them to chemists at the agency's St. Louis laboratory for analysis.

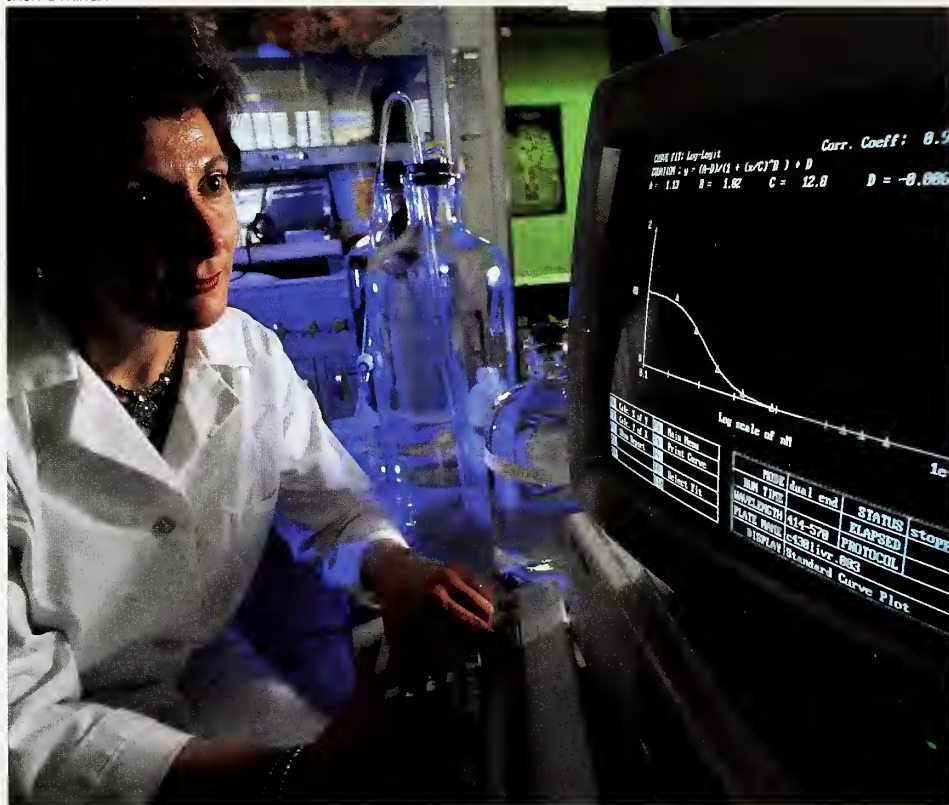
Once at the lab, the specimens are scrutinized using a high-performance liquid chromatograph—standard equipment in many laboratories. But tomorrow the chemists might complement that approach with monoclonal antibody assays.

Agricultural Research Service chemist David L. Brandon says the new assays hold the promise of "dramatically speeding up testing without compromising accuracy."

Brandon and colleagues Anne H. Bates, Ronald G. Binder, William C. Montague, Jr., Elizabeth H. Sweet, and Robert E. Wilson at Albany, California, have developed four distinct monoclonal antibodies. Each will rapidly and inexpensively detect a specific benzimidazole, such as fenbendazole, in concentrations as low as 1 part per billion. That's equivalent to 1 second in 32 years. They aim for antibodies to four additional benzimidazoles this year.

The potential ease and convenience of the new assays might pave

JACK DYKINGA



Chemist Anne Bates works on an antibody test for a benzimidazole—a livestock deworming drug. (K-4002-1)

the way for boosting the number of samples checked each day by FSIS chemists in the laboratory.

Once individual tests are complete, Brandon envisions reworking them into a multi-drug screening procedure, capable of detecting all key benzimidazole compounds at once. With further work, this drug-screening kit of the future might prove rugged and convenient enough for packinghouse inspectors to check carcasses on the spot. For that to happen, however, the test would have to be exceptionally quick, so that it won't stall inspection and grading.

The agency's 1989 laboratory screening of nearly 2,000 samples of domestically produced meat and poultry and 1,173 imported animal carcasses revealed no violations of federally approved safe limits for benzimidazoles. Despite this clean

record, FSIS keeps benzimidazoles on the list of chemicals it monitors nationwide because of the potential side effects that high doses could cause in humans.

Those problems show up in people—notably in developing countries—who sometimes take benzimidazoles in high doses as a prescription drug to kill internal worms. Medicinal doses for those patients can cause dizziness, nausea, vomiting, anorexia, diarrhea, drowsiness, and headaches.

But FSIS screening makes it unlikely that anything near those quantities of the drugs would end up in the meat and poultry we buy at the supermarket or butcher shop, or order at a restaurant. FSIS' William T. Hubbert, who oversees the agency's drug monitoring of meat and poultry, says he knows of no instance of

benzimidazole-related side effects occurring in people as a result of eating meat.

Even so, the agency adheres to a strict safety margin in its drug residue testing, according to Hubbert in Washington, D.C. That means the maximum allowable benzimidazole drug residue in an animal sample is many times less than likely to produce any sort of measurable side effect in people.

The benzimidazole drugs that the antibodies detect can kill more than two dozen different kinds of debilitating worms, including stomach worms such as the barberpole worm, tapeworms and other intestinal worms, lungworms, and liver flukes.

Many of these parasites are pervasive; in fact, any place in the United States that has livestock will also have parasitic worms.

To keep cattle healthy, many ranchers routinely deworm their herds. Commonly, they use a long tube to squirt a liquid or toothpaste-like formulation of benzimidazole into each animal's mouth.

After treatment, ranchers must allow a few days to a few weeks to elapse before slaughter. The withdrawal time ensures that their livestock have used up the medicine. Each drug's label spells out withdrawal time; albendazole, for example, requires a 27-day wait.

The monoclonal antibodies that ferret out traces of these drugs are the product of man and mouse. Scientists like Brandon rely on the mouse's immune system to produce antibodies, a type of protein.

In this case, the scientists trick the mouse's immune system into forming antibodies to a benzimidazole deworming drug.

To make a monoclonal antibody, the Albany team injects laboratory mice with one of the benzimidazoles. The mouse spleen cells respond by

making a flurry of antibodies—including some that specifically target the incoming drug.

The researchers then remove these spleen cells and fuse them with mouse cancer cells—harmless to humans—in a test tube. The result: new, hybrid tumor cells, or hybridomas. In the laboratory flasks, these hardworking hybridomas become tiny factories, churning out antibodies. The supply is plentiful because hybridomas reproduce rapidly—a characteristic of cancer cells.

The researchers repeat the process for each drug, making separate monoclonal antibodies for each. The new antibodies will bind readily to drug residues in a liquefied sample. Later, when exposed to a special solution, samples with drug residues will take on a faint green tinge. Drug-free samples, in contrast, turn a

JACK DYKINGA



Using monoclonal antibodies, chemist Anne Bates tests for benzimidazole residue. (K-4003-1)

distinctive blue-green in about 15 minutes.

Sound simple? It isn't. "There can be lots of pitfalls," says Brandon. "It can be difficult to get the mouse to make an antibody to only the compound you want. Or, sometimes you can't get the hybridoma cells to keep producing antibodies.

"Making monoclonal antibodies," he says, "is widely regarded as a standard procedure. But it's really a combination of art, science, and luck."—By **Marcia Wood, ARS.**

David L. Brandon, Anne H. Bates, Ronald G. Binder, William C. Montague, Jr., Elizabeth H. Sweet, and Robert E. Wilson are with the USDA-ARS Food Safety Research Unit, Western Regional Research Center, 800 Buchanan St., Albany, CA 94710 (415) 559-5783. ♦

JACK DYKINGA



Chemist David Brandon evaluates a screening assay for benzimidazole residue at ARS' Food Safety Unit in Albany, California. (K-4001-1)

From Fiber to Fabric: A Better Blend

Agricultural Research Service scientists are re-engineering the clothes you wear. They have patented a new way to blend more cotton fiber with synthetic fiber to make yarn. These new yarns result in fabric that is strong yet comfortable, says inventor A. Paul S. Sawhney, a research cotton technologist with ARS' Fiber Quality Research Unit in New Orleans.

Typically, blend yarns are 65-percent synthetic fiber and 35-percent cotton. But a new spinning technique developed by Sawhney and co-inventors Craig L. Folk, Kearny Q. Robert, and Linda B. Kimmel changes the way blend yarn is made.

"This invention allows textile companies to make a fabric with the comfort and breathability of 100-

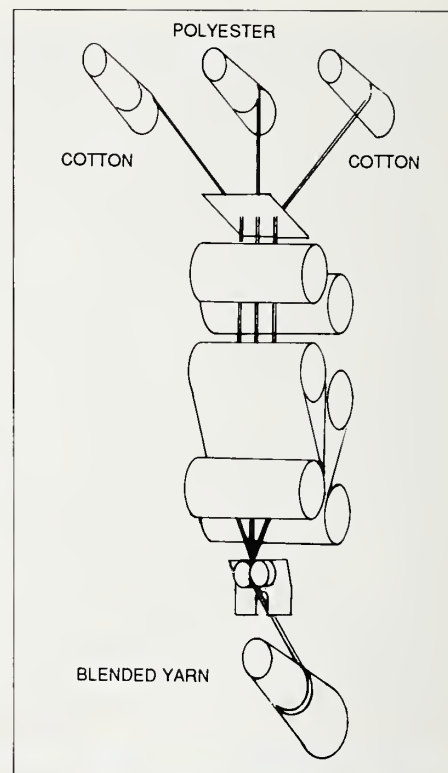
percent cotton, without sacrificing the strength and finishing advantages of manmade fiber," says Sawhney.

Blended yarns became popular when consumer demand for 100-percent synthetic fibers like polyester and nylon decreased in the 1970's.

Consumers started choosing cotton because of its durability, comfort, and absorbency. They missed, however, the no-iron features of the synthetics. This led to the development of blends of cotton and synthetic fibers.

Blends provided the good features of both fibers and became a middle-of-the road fabric that pleased the consumer. But current blend yarns do have their disadvantages.

In fabrics made from conventional blend yarns, the cotton fiber wears and breaks off, while the synthetic



PERRY A. RECH



Cotton technologist A. Paul Sawhney observes the polyester staple-core/cotton-wrap spinning system, a new way to blend more cotton fiber with synthetic fiber. The yarn results in a fabric that is strong yet comfortable. (K-3855-20)

fiber doesn't, says Sawhney. This can cause pilling, which is a very serious problem. "I think we have solved that problem."

Pilling—the formation of small unsightly balls—happens because synthetic fibers are stronger than cotton fibers, so they don't wear in the same way. As a result, synthetic fibers project from the surface of conventional blend fabrics.

In the invention developed at the Southern Regional Research Center in New Orleans, stronger synthetic fibers are hidden under a layer of cotton fibers and don't project out of yarn to the surface.

Currently cotton and synthetic fiber are randomly combined and wound on a bobbin called a roving. The roving bobbin is put on a spinning machine where the blended fibers are spun into yarn.

The new technology combines fibers from separate rovings that are 100-percent cotton and 100-percent synthetic, Sawhney says. A unique device is used to combine the two fibers into a composite yarn. This is known as a wrap yarn. [See illustration on facing page.]

This spinning technique typically involves the use of two cotton roving bobbins and one polyester bobbin. The three roving bobbins, with the polyester bobbin in the middle, are suspended above the spinning frame, Sawhney says.

The three rovings are spaced about one-fourth to one-half inch apart and drawn through a series of drafting rollers. When the fibers meet after emerging from the rollers, the synthetic fiber is sandwiched between the two strands of cotton fiber, creating a strong high-cotton-content yarn with nearly a 100-percent cotton surface, he says.

"It is very similar to an electrical wire or cord where metal wire is

entrapped by a rubber coating," Sawhney says. "In this case, the metal wire is synthetic fiber and the rubber coating is cotton.

"Also, there is a unique interlocking of fibers that prevents stripping of the cotton sheath," Sawhney says.

"The lead ends of cotton fibers from the two cotton rovings get trapped first, followed by the tail ends of the fibers spinning around the core yarn.

"Again, it's like electrical wire," he adds. "You don't want the rubber coating sliding off of a metal wire."

By segregating the cotton with the polyester in the middle, the invention enhances the benefits of both fibers while eliminating pilling. The current blend yarn has its fibers randomly scattered in the yarn, diluting the performance of each fiber.

PERRY A. RECH



Cotton technologist Paul Sawhney examines a finished fabric roll of polyester staple-core/cotton-wrap. (K-3854-19)

Sawhney says the textile industry might object to the cost involved in using two cotton rovings. However, the extra expense to prepare the rovings should be more than offset by making a premium-priced yarn.

"The fabric is just more dimensionally stable," he says. "It [the invention] also gives fabric better mechanical properties of tear and tensile strengths. I think consumers will like this new cotton-rich product. It offers greater comfort and better appearance than currently available no-iron blends."

Researchers have experimented with composites as high as 90-percent cotton, but found the 65-percent cotton blend comparable to a conventionally made 65-percent synthetic blend.

The invention doesn't limit core-yarns to cotton and man-made fibers. Scientists are also experimenting with fibers like wool, mohair, and goat hair.

Also, the invention can make coarse or inferior grades of cotton more marketable because it essentially layers the coarse fiber inside the higher quality fiber, Sawhney says.

"There are also a lot of specialty yarns that could be produced using this method," Sawhney adds. "We're continuing to work on ways to improve this technology."

Ann Whitehead, coordinator of the U.S. Department of Agriculture's National Patent Program, notes that the invention is patented and available for licensing.—By **Bruce Kinzel**, ARS.

A. Paul S. Sawhney is in the USDA-ARS Fiber Quality Research Unit, Southern Regional Research Center, P.O. Box 19687, New Orleans, LA 70179 (504) 286-4568. ♦

All-Soy Ink

Splashes Into Print



KEITH WELLER

Soybean oil (left) gives a much lighter color vehicle for ink than a petroleum-based formula (right). (K-3617-6)

Think about the telltale signs of reading the morning newspaper. Yes, we're talking about black, messy ink that rubs off on your hands. It could be a thing of the past thanks to new inks made with a 100-percent soybean oil base developed by ARS scientists in Peoria, Illinois.

Chemist Sevim Erhan expects a wide and immediate use of both black and color soybean oil inks because "not only can they be made at a lower cost than petroleum-based inks, but the soy oil gives perfect penetration of the pigments into newsprint. It's this penetration that keeps the ink on the paper where it belongs," she says.

Readers of Agricultural Research may wonder whether their favorite magazine is printed with ARS-developed 100-percent soy oil ink. The answer is no, not yet—but we'll keep you posted; the situation may change.

In the meantime, we've printed this issue in a commercially available ink that contains about 30-percent soybean oil and is formulated for glossy paper.

One hundred percent soy-oil ink still requires improvement in how it is absorbed and how it dries on coated paper stock. Erhan and Bagby intend to develop a separate formula for glossy paper; they expect to begin testing it in a year or so.

Blending an ink from soybean oil was tackled by the American Newspaper Publishers Association (ANPA) in the early 1980's.

ANPA's goal, which has not entirely been met, is to provide an ink with a stable price and one that is derived mainly from a renewable resource. To this end, they began experimenting with several ink formulations that were partly soy oil and partly petroleum products.

By 1985, ANPA developed a newsprint ink made from a soybean oil, petroleum, and carbon black pigment. But the hybrid ANPA ink which was about 30 percent soy oil cost 70 percent more than conventional petroleum inks—a bleak fact that kept it from being widely used.

Hybrid color inks, on the other hand, have been more readily accepted by the industry because they have proven cost competitive with traditional ink. Erhan

explains that the cost of making colored soy inks is more compatible because the price is based more on the cost of the pigment than on the oil, and with soy oil in the base, the pigments go further.

Interest in the hybrid ANPA soybean color ink has grown so much that about a third of ANPA's members have already switched to partial soy-based color inks.

Erhan overcame the costliness of black and color soybean ink by formulating a lighter color vehicle to reduce the amount of pigment used and by displacing a more expensive petroleum resin. This should lower the cost of 100 percent soybean ink by making it go further.

Another reason Erhan expects her 100 percent soy-oil formulation to be adopted

quickly by newspaper publishers is that the ink is completely compatible with newspaper printing presses now in use. No special or additional equipment would be needed to make the switch.

In 1987, an Iowa paper—the Cedar Rapids Gazette—was one of the first newspapers to do a press run using the ANPA-approved soy ink, both black and another color. “The test was so successful that we decided to completely convert to the soy color inks,” says Lon Myers, director of operations for the Gazette. “We reduced the density of the black soy ink to compensate for the [remaining] ruboff problem that occurs. We're waiting for the word that a soy oil ink is available that won't smudge on your hands,” he adds.

Myers also says that the cost of black soy ink is a consideration many newspaper publishers would face

before they would make a switch from petroleum-based black ink formulations.

The secret of using natural oils to make inks was known as early as 2500 B.C., when the Egyptians and Chinese made inks from such things as berries, bark, linseed oil, and soot.

Richard Dunkle, director of ARS' National Center for Agricultural Utilization Research in Peoria, says that it is not surprising that the discovery and development of a cost-competitive soy oil ink should come from the Peoria labs. “Scientists here have been seeking new, commercial uses for agricultural crops for more than 50 years,” he says.

Currently, production of the ANPA soy-based ink uses 5 to 10 million bushels of soybeans yearly. “The total potential, if all printers converted to 100-percent soy ink, could be about 100 million bushels,”

says Stu Ellis, Director of Domestic Marketing Programs for the American Soybean Association.

The two largest soybean-producing states promote use of soybean-oil-based inks. In Illinois, all state-funded printing must be done exclusively with soy oil inks. Two of Iowa's publications—the Iowa Farmer Today and the Cedar Rapids Gazette—were among the first to switch to partial soyoil inks.

Ink for every use—from money to paper grocery bags to business forms—requires a formula specifically developed for that use.

Erhan's ink formulations are easily adjustable to meet various needs. She says, “the ink formu-

KEITH WELLER



Chemists Sevim Erhan and Marvin Bagby check the density of type printed with all-soy ink. (K3999-12)

las we've developed have a wide range of viscosity and tackiness." They should be a boon to printers looking for a quality ink and an easier clean-up. These factors are important considerations when making an ink to meet the demands of printers, each with slightly different needs.

Marvin Bagby, research leader in the Oil Chemical Research Unit, stresses the need to make products from renewable resources. "Our goal is to expand the market for agricultural crops in the 1990's," he says.

Erhan and Bagby have applied for a patent on the 100-percent soyoil ink and the process for making several formulas. Under a formal cooperative agreement with ARS, Flint Ink Corporation in Ann Arbor, Michigan, has agreed to do a study comparing the new ink with conventional printing ink.

Besides Illinois, six other states — Iowa, Minnesota, Missouri, Ohio, South Dakota, and Wisconsin—have legislation passed or pending that requires use of soy ink on all printing jobs contracted by the state.—By **Linda Cooke, ARS.**

Sevim Erhan and Marvin Bagby are in the ARS-USDA Oil Chemical Research Unit, National Center for Agricultural Utilization Research, 1815 N. University Street, Peoria, IL 61604 (309) 685-4011. ♦

KEITH WELLER



Chemist Sevim Erhan tests trapping capabilities—the ability to print a wet ink film over previously printed ink—of her experimental soy inks on the “Little Joe” printing press. (K-3997-16)

Just Call Her INK 26

In 1987, the American Newspaper Publishers Association asked USDA's Agricultural Research Service to help them meet an industry goal of a readily available newspaper ink that is stable in price and mainly derived from a renewable resource.

Sevim Erhan joined ARS shortly afterwards, having just completed her doctorate in organic polymer chemistry at Western Michigan University in Kalamazoo.

She became so excited about her work at the National Center for Agricultural Utilization Research that she had her Illinois license plate personalized with INK 26.

From COMAX to HOPPER

Computer Programs Help the Environment

Computer programs developed by Agricultural Research Service scientists are now striving to keep the environment clean while helping farmers and ranchers in getting better returns on their operations.

"The two goals go hand in hand," says Stephen Rawlins, ARS' National Program Leader for Soil Erosion and Models, Beltsville, Maryland. No farmer or rancher wants to apply any more than the minimum amount of expensive pesticides and fertilizers, and the less applied, the less danger some may end up in water supplies."

Of these programs, perhaps the one that has gone furthest is the GOSSYM/COMAX System. Its first name is taken from the scientific name for cotton—*Gossypium*—and from the word "simulation."

"COMAX" is an acronym for Cotton Management Expert. It is now used on at least 300 and perhaps as many as 500 cotton farms in 15 states.

"This year marked a significant increase in the number of cotton consultants who use the system," says James M. McKinion, electronics engineer and research leader of the ARS Crop Simulation Research team at Mississippi State University.

Cotton consultants are specialists who advise growers on how to manage their cotton farming operations. Each one may have between 10 and 50 clients who benefit when they adopt COMAX. McKinion says, "The potential annual benefit, if used on all 15 million acres of cotton grown in the United States, would approach \$2.1 billion."

The earliest version was tested on a farm in Mississippi and on one in South Carolina in 1984. [See *Agricultural Research*, September 1986, pp. 6-10.]

Kenneth B. Hood, a cotton grower at Sumner, Mississippi, started using GOSSYM/COMAX on 800 acres in

1986; it worked so well he switched his entire 5,000 acres to it last year.

"GOSSYM/COMAX has improved vastly since then and it's made a big difference to my operation, environmentally as well as economically," Hood says.

"It's taken some of the guesswork out of cotton farming. Now I know what to do 15 days before I need to do it. I know when to apply nitrogen fertilizer and water before the plant goes into stress. Not only do I apply the fertilizer and water in lower amounts, I use them only according to the cotton's needs.

"I spoon-feed nitrogen to my plants, rather than giving it to them all at once in one big surge. You can lose a lot of nitrogen when you're farming in the rain belt."

GOSSYM/COMAX helps growers like Hood decide timing and amount of fertilizer and irrigation and when to use chemicals that control growth, boll opening, and crop termination.

Growers can also use the system to determine planting date, plant populations, and row spacing for their specific growing conditions. One of the agency's more elaborate computerized decision-aid systems, GOSSYM/COMAX uses a program that contains a series of rules based on the researcher's knowledge of the GOSSYM simulation and of agonomic practice. The computer sorts through these before making recommendations. The system can simulate an entire growing season in about 4 minutes on IBM-compatible personal computers, predicting, among other

NOAH PORITZ



Ecologist Jim Berry makes a quick query of the Hopper computer program to find out if grasshoppers are likely to be a problem. (K-4005-1)

things, the best time to harvest the crop and its probable yield.

"I'm trying to use GOSSYM/COMAX to shorten my growing season from 170 to 150 days, taking advantage of the timely operations it allows," Hood says. "We only have a 40-day safe period to harvest before rains and frost finish us off. Even 10 extra days are quite important to us."

Another computer model, called Hopper, is helping ranchers protect their rangeland.

"Grasshopper populations can be kept in check with insecticides and biological controls," Hopper co-developer James S. Berry says. He is an ecologist at the ARS Rangeland Insect Laboratory, Bozeman, Montana. "But because both methods are relatively expensive in relation to the value of rangeland grass, ranchers have been reluctant to apply them until grasshoppers have already inflicted costly damage."

"Occasionally, the opposite scenario takes place. Ranchers may unknowingly use control measures when not really needed."

Hopper, which also runs on IBM-compatible personal computers, helps ranchers decide what to do if grasshoppers appear. The easy-to-use program selects appropriate management strategies to control the insects and provides ranchers with a profit-or-loss estimate for any action, including doing nothing.

William P. Kemp and Jerome A. Onsager of the Rangeland Insect Laboratory developed the first version of Hopper in cooperation with Hal E. Lemmon. Lemmon, a computer scientist at Albany, California, was instrumental in developing GOSSYM/COMAX.

"We plan to use Hopper at our public meetings to show ranchers how to evaluate their options," says Timothy J. McNary, entomologist with USDA's Animal and Plant

TIM MCCABE



Electronics engineer James McKinion (right) and Mississippi cotton farmer Frank Mitchner, a user of the GOSSYM/COMAX system, check an automated weather station. It feeds daily weather information into Mitchner's farm computer to update its predictions for cotton yield and harvest dates. (K-2228-11)

Health Inspection Service, Cheyenne, Wyoming. "They will be able to see how much money they will save or lose by selecting various control efforts. It will really help them make sound business decisions."

"Another great advantage is the safety information it contains. It lists all the commonly used grasshopper insecticides with instructions on use and how to treat accidental spills."

A third computer model uses display windows, pop-up and pull-down menus, dialog boxes, and computer graphics to create a sophisticated, user-friendly interface. This model simulates the movement of nonvolatile organics and inorganics, including trace elements—salts, pesticides, and fertilizers—through soil. It's called TETrans, for Trace Element Transport.

"TETrans can be used to assess the potential threat of a nonvolatile chemical spill to the groundwater," says Dennis L. Corwin, ARS soil scientist at the U.S. Salinity Laboratory at Riverside, California. "The computer program would quickly determine how the chemical was moving—without first determining the complex variables most other programs require."

"The program is exceedingly impressive and is the first model I've seen that I really want to use. Because it's so very easy to use and simple to set up and modify, I'm hoping my students will do more than use TETrans to learn how chemicals and chemical elements move in soil," says Arthur Busby, assistant professor of geology, Texas Christian University, Fort Worth. "Hopefully they'll also come to appreciate it as a flawless implementation and an example of how computer models should be written."

"We designed TETrans to be used by individuals who are not professionals in contaminant transport but

NOAH PORITZ



Jim Berry uses a sweep net to collect grasshoppers. Information gathered from field surveys is entered into the Hopper program to help land managers evaluate management alternatives. (K-4004-1)

who nevertheless require information concerning the movement of potential contaminants through soils. These users include farmers, field personnel in USDA's Soil Conservation Service, the U.S. Environmental Protection Agency, and private consultants," says Corwin.

He adds, the information TETrans needs to make its recommendations is generally readily available.

TETrans operates on both Macintosh and IBM-compatible computers. However, the sophisticated user interface with its impressive graphics is available only on the Macintosh.

Morris G. Huck, ARS soil scientist at Urbana, Illinois, adds, "My overall impression is that this is a very clean program that does exactly what it claims. Our collaborators in the Knowledge-Based Systems Labora-

tory here in the Department of Agronomy at the University of Illinois would like to incorporate TETrans in a larger decision-support system."

TETrans could be coupled to a geographic information system to assess wide-scale distribution of potential contaminants over the landscape. It will be used to help predict sources of salt seeping into the groundwater in Central California's Westlands Water District.

Barton L. Waggoner, ARS geophysicist at the salinity lab, helped Corwin write the program. They have distributed about 125 copies so far.—**By Dennis Senft, ARS. Don Comis, ARS, contributed to this article.**

Stephen Rawlins is with the National Program Staff, USDA-ARS, Bldg. 005, BARC- West, Beltsville, MD 20705 (301) 344-4034. James M. McKinion is with the USDA-ARS Crop Simulation Research Unit, P.O. Box 5367, Mississippi State, MS 39762 (601) 324-4375. James S. Berry is at the USDA-ARS Rangeland Insects Laboratory, S. 11th Avenue, Bozeman, MT 59717 (406) 994-3051. Dennis L. Corwin is at the USDA-ARS U.S. Salinity Laboratory, 4500 Glenwood Drive, Riverside, CA 92501 (714) 369-4819. Hal E. Lemmon is at the USDA-ARS Systems Research Laboratory, 800 Buchanan Street, Albany, CA 94710 (415) 559-5965. ♦

What's New in Oilseeds? Check Out Crambe!

Most farmers would call crambe (KRAM-bee) a new crop, but to one Agricultural Research Service chemist at Peoria, Illinois, it's an old one whose time has come.

Known botanically as *Crambe abyssinica*, this member of the mustard family originates from the Mediterranean area. Its seed contains 30 to 35 percent oil, nearly twice that of soybeans. Of this, 55 to 60 percent is composed of erucic acid.

According to Kenneth D. Carlson, crambe oil is a good source of long-chain fatty acids—useful as a chemical feedstock because the longer the hydrocarbon chain, the more things that can be made from it. Potential industrial uses include a wide range of plastics, coatings, and lubricants.

Crambe is best grown in areas of the Midwest, upper plains states, and Northwest. It's anticipated that about 5,000 acres will be grown this year, mostly in North Dakota, says Carlson, who works at the National Center for Agricultural Utilization Research.

Many small-grain farmers already have the expertise and equipment to grow and harvest crambe.

Crambe oil contains 8 to 9 percent more erucic acid than industrial rapeseed oil. Up to 40 million pounds of high-erucic-acid oil are used annually in the United States—mostly imported from Poland and Canada. An estimated 50,000 acres of crambe would be needed to supply the U.S. need. Currently, only 20,000 acres of all high-erucic-acid-oil crops are grown here.

"If more crambe and industrial rapeseed were grown, we could reduce our reliance on imports," says Carlson.

One product from crambe-derived erucic oil, Nylon 1313, developed at the Peoria Center in the early 1970's, could become important in producing



parts for cars and trucks if supplies of erucic oil were plentiful.

Nylon 1313's incredible resistance to moisture makes it ideal for truck air brake lines, hydraulic and fuel lines, gears, tubing, and fasteners. The moisture-resistant quality is also useful for other products: gears for clocks, water meters, gas pumps, and communication cables.

An Expert Approach

Given the potential for producing erucic acid locally in the United States, the questions become: Should a particular farmer grow crambe and, if so, what's the best way to grow this crop at a particular location?

An ARS-Purdue University team developed a computer program that can help Indiana farmers decide whether to take the plunge. Called CRAMBE, it evaluates the long-term economic risks and benefits of producing the crop. The knowledge expert for this program was a Purdue agronomist, Ellsworth Christmas. The soil and climate information is specific to Indiana.

"The program is an expert system—one that mimics human decision-making processes," says ARS agricultural engineer John R. Barrett, a co-developer. "It's coupled with a model that simulates what would happen, if, for example, an Indiana farmer rotated crambe with corn and soybeans."

Barrett, who is an expert systems computer scientist at the National Soil Erosion Research Laboratory in West Lafayette, Indiana, says the program can provide recommendations about the feasibility of growing crambe based on site- and situation-specific agronomic conditions.

A producer can input data into the program such as crop acreages, rotations, and yields, and the equipment and labor available to grow and

harvest the crop. In addition, economic data would be entered: the farmer's fixed and variable costs, commodity prices for crambe, and costs for other

"The program is an expert system—one that mimics human decision-making processes," says ARS agricultural engineer John R. Barrett, a co-developer. "It's coupled with a model that simulates what would happen, if, for example, an Indiana farmer rotated crambe with corn and soybeans."

crops that a farmer might consider planting instead.

The result: The computer issues a advisory that might read: DO NOT PLANT, or GROW 350 ACRES THIS YEAR IF MARKET VALUE OF CRAMBE IS \$265 PER TON.

In addition, Christmas says the program will provide a summary report that gives economic analysis, planting dates and rates, equipment needed, recommendations for fertilizer, and management information, such as the tillage method best-suited for the particular field and the optimal time to harvest—right down to the proper combine settings.

The Future for Crambe

In 1986, USDA began a High Erucic Acid Oils Project. This project is a

federal-state consortium governed by two USDA agencies—the Cooperative State Research Service and ARS—and eight states: Idaho, Illinois, Iowa, Kansas, Missouri, Nebraska, New Mexico, and North Dakota. The goal: To promote development of domestic sources for crambe and rapeseed.

After the oil is extracted, crambe meal has a potential use as a cattle feed. The Food and Drug Administration has approved it for ruminants, but says it cannot be safely fed to pigs or poultry.

Crambe is one of several plant introductions with promise as an industrial oil seed crop. The impediment to more widespread introduction of crambe into U.S. agriculture has been low crude oil prices combined with management and/or economic considerations that may vary within a production area. If crude oil prices were to rise and supplies were to dwindle, the importance of crambe and other alternative crop-based oils would likely increase.—By **Linda Cooke** and **Dvora Aksler Konstant**, ARS.

Kenneth D. Carlson is in USDA-ARS New Crops/Oil Chemical Research, National Center for Agricultural Utilization Research, 1815 N. University Street, Peoria, IL 61604 (309) 685-4011. John R. Barrett is at the USDA-ARS National Soil Erosion Research Laboratory, Purdue University, West Lafayette, IN 47907 (317) 494-1188. ♦

Will Soy-Spiked Pellets Please Palates of Succulent Shrimp ?

If feeding your guppies ever got to be a hassle when you were a kid, consider the shrimp farmer's plight. If the aquaculturist's tasty but troublesome crustaceans aren't fed what they want, when they want it, they'll likely eat each other—and the farmer's profits.

Nutritious feeds to stave off shrimp's cannibalistic instincts and keep the animals healthy and fast-growing are shrimp farming's biggest expense. Feed costs hinder growth of shrimp aquaculture in the United States, says ARS research biologist Chhorn E. Lim. He's in charge of the Tropical Aquaculture Research Unit at Kaneohe, Hawaii.

U.S. production of farm-raised shrimp in outdoor tanks and ponds is so small that no federal agency even tracks it. The National Marine Fisheries Service, however, tallies the ocean catches of American shrimpers, logs shrimp imports, and estimates the amount of shrimp we eat.

In 1989, imports plus the harvest by U.S. shrimpers totalled 779 million pounds, worth about \$2.2 billion, wholesale. Of that catch, we each ate an estimated 2.3 pounds of shrimp.

One way to slash the high cost of shrimp feed might be to substitute more soybean protein—inexpensive and readily available—in place of the pricier ocean-derived proteins typically offered in premium shrimp feeds. "Right now," says Lim, "very little soy is used in shrimp feeds. But the more soy you can put in the feed, the cheaper it will be."

Lim and colleagues have shown that young shrimp will thrive on feeds that contain about 30 percent soybean meal, with the remaining protein from marine organisms, such as anchovies. These results agree with earlier experiments conducted in Asia by the American Soybean Association.

Here's how protein costs compare: Soy meal ranges from \$200 to \$250 a

taste of catfish, and their feed is about 50 percent soybean meal. And farm-raised tilapia, a perchlike fish, eat feeds that are about 35 percent soy.

But shrimp may balk if their feed has too much soy, according to Lim's preliminary results. When feed contained more than 42 percent soybean meal, the shrimp ate less, so didn't gain as much weight as their counterparts.

For his soy feeding experiment, Lim used a white shrimp, *Penaeus vannamei*, a saltwater species that is widely marketed in the United States. He reared the shrimp indoors in two dozen small glass tanks.

Even though the young shrimp did well on soy feeds that stayed below the 42 percent cutoff point, the researchers were concerned about natural compounds, called trypsin inhibitors, that soy contains. The inhibitors have been known to interfere with some animals' ability to get the full benefit of soy protein.

When soybeans are converted into flour or other soy products, an extra step, such as heating moistened soy, will usually knock down 85 to 95 percent of the inhibitors. But each extra step increases soy's cost, says ARS research chemist David J. Sessa at Peoria, Illinois.

JACK DYKINGA



An ARS-developed experimental shrimp feed containing soybean meal. (K-3506-13)

ton. Coarsely ground fish meal made from anchovy, tuna, or menhaden may start at \$385 a ton; shrimp meal (made from shrimp heads, trimmed before shrimp reach the supermarket or restaurant) can cost \$550 a ton; and squid meal can command \$1,300 a ton and up.

Will adding more soy to feeds change shrimp's flavor? Probably not, says Lim. Soy doesn't affect the

JACK DYKINGA



A young shrimp, *Penaeus vannamei*, feeds on a soy-based pellet. (K-3507-12)

If inhibitors don't bother shrimp, perhaps the step could be skipped. To find out, Sessa and Lim concocted six different soy formulas, containing trypsin inhibitors at concentrations as high as 6 parts per thousand. That's about 2 parts less than raw, unprocessed soybeans.

In Hawaii, Lim fed the soy, blended with vitamins, minerals, fats, and other ingredients, to the *P. vannamei* shrimp.

Surprisingly, the shrimp shrugged off the inhibitors. Those that gained the most weight ate the least processed, least expensive soy—the feed that had the highest amount of trypsin inhibitors. The study is apparently the first to correlate shrimp growth with the amount of trypsin inhibitor in their feed.

For experiments, Lim typically presses feeds into pellets that are about one-quarter-inch long and one eighth inch in diameter. Shrimp's somewhat messy eating habits could make it a challenge for feed mills to process tomorrow's soy-based feeds into pellets shrimp can manage.

Lim says most finfish—catfish or salmon, for example—"will swallow any suitably sized pellets once they've learned to feed on them."

But shrimp shred pellets with their external mouth parts. That can make pellets disintegrate even sooner than they normally would under water.

Then, as they pump water through their gills, shrimp create a small current that can sweep light, fine-textured particles of deteriorating pellets out of their reach. "The particles drift up and away from the shrimp like a plume of dust," says Warren G. Dominy of the Oceanic Institute at Waimanalo. Dominy and Lim collaborated in an extensive study of feed pellets.

Uneaten pellet particles not only deprive shrimp of needed nourishment, but also accelerate unhealthful

LOUISE & NEAL INC. ©



pollution of ponds and tanks. Decomposing particles use up oxygen and may produce toxic compounds.

The texture of soybean meal poses another aggravation. Soy particles don't bind readily. So, to keep pellets from falling apart before shrimp can eat them, feed mills add binders—edible, glue-like compounds that help ingredients stick together. But the choice of binder and the way it's processed at the feed mill are critical.

In their test of more than a dozen different binders, Dominy and Lim found several that worked well with one experimental, soy-based feed, processed through a pellet mill. Binders that scored high in that test, however, might not necessarily be the best to use with other recipes, Dominy cautions.

Feed mills need to be certain the binder they choose works well with the other ingredients in the feed," he

says. "They also need to make sure that they have the right equipment to meet any special requirements for processing the binder and that they closely follow the binder manufacturer's recommendations."

That means, for example, a feed mill must use the temperature and amount of water the binder manufacturer specifies. "Often that's not done," Dominy says, "and pellets fall apart long before they should."—By **Marcia Wood, ARS.**

Chhorn E. Lim is with USDA-ARS Tropical Aquaculture Research Unit, P.O. Box 1346, Kaneohe, HI 96744 (808) 247-6631. David J. Sessa is in USDA-ARS Biopolymer Research, National Center for Agricultural Utilization Research, 1815 North University, Peoria, IL 61601 (309) 685-4011. ♦

Irrigating Drip by Drip

Four years of drought in California have underscored the need for water conservation through irrigation technology.

The best tomatoes from California's huge Harris Farms grow in fields fitted with a hidden network of underground pipes.

The subterranean system saves water by delivering it precisely to the place thirsty plants need it most—their roots.

"We can grow an excellent crop with only 17 inches of water, instead of the usual 24 to 27," says Harris Farms manager Richard L. Lobmeyer. He oversees 18,000 acres of vegetables, fruits, nuts, and cotton that the company raises in the San Joaquin Valley—the world's most productive agricultural region.

And while some growers are put off by the high initial costs of installing the buried pipes, plus yearly operating expenses, Harris profits have the company "grinning all the way to the bank," says ARS soil scientist Claude J. Phené at Fresno.

An authority on buried drip, Phené in 1987 grew a record tomato harvest—the equivalent of 100 tons per acre—on a California research plot plumbed with an underground watering system. Tomato fields there typically yield 30 tons per acre, says Phené, who is director of ARS' Water Management Research Laboratory. Donald M. May, farm adviser for Fresno County, cooperated in the experiment.

With 320 acres at Harris Farms already boasting below-ground piping, manager Lobmeyer says the company will convert another 300

CON KEYES



A circle of string, placed by soil scientist Claude Phené, marks the distance water has soaked out to cotton roots from an underground drip irrigation line. (K-3231-16)

acres of tomato fields to buried drip within a year. "The size and quality of our tomatoes," he says, "is better with underground drip."

Lobmeyer has found that cotton also flourishes on buried drip, so-called because tiny emitters in the below-ground pipes squeeze water out a drop at a time.

A 40-acre plot of cotton, fed this way, leads yield and profit ratings in the first year of a 2-year comparison of irrigation systems at Harris Farms.

Funded by the State of California, the new project scrutinizes buried drip and three types of surface irrigation—conventional furrow, improved furrow, and an irrigation machine called LEPA (low-energy, precision applicator), says Richard B. Smith. He's a senior agronomist with

Boyle Engineering Corporation, contractors for the venture.

Findings should help beleaguered San Joaquin Valley growers, now grappling with water rationing and their fourth straight year of drought. Growers are also hassled by irrigation drainage that has nowhere to go. In the past, underground drains carried excess irrigation water away from plant roots, to avoid drowning them in unused water laden with selenium, boron, nitrate fertilizer, and other pollutants. In the mid 1980's, however, drains were plugged when it was discovered that evaporation ponds, where outflow emerged, accumulated high levels of selenium and led to deaths and deformities of waterfowl.

Harris' subsurface-irrigated cotton plants yielded a respectable 3.06

bales (about 1,530 pounds) an acre, according to a report from Phené, Smith, and co-investigator James D. Oster of the University of California, Riverside.

That's nine-tenths of a bale more per acre than the next highest yielding system in the experiment, the conventional furrow.

Capital costs for underground drip were highest (about \$1,350 an acre). The next most expensive system, the low-energy precision applicator, cost \$584 an acre. But buried drip offered the highest net returns—\$268 an acre, or double that of the next most profitable option, conventional furrow.

Harris applied 24 inches of water to the buried-drip plot, slightly more than with the low-energy system and about 20 percent less than in conventional furrows.

Phené has reaped outstanding harvests, with notable water savings, from experiments with cotton, tomatoes, sweet corn, and cantaloupe on closely monitored research plots of about 4 acres. He says the Harris Farms results "could do a lot to convince Valley growers that subsurface drip can work just as well on large commercial acreages."

A proponent of buried drip systems for the past 20 years, Phené says the approach often drastically reduces overirrigation and thus prevents pollution of the underground water supply. What's more, with buried drip there's no water standing on the ground, so less moisture is lost through evaporation.

Because topsoil stays dry, tomatoes, cantaloupe, and other crops that sit on the ground aren't bothered by the usual molds and rots that can flourish in soggy soil.

Growers neighboring Harris Farms will likely benefit most from the demonstration project. But farmers elsewhere who rely on irrigation



Tomatoes thrive with subsurface drip irrigation at Harris Farms in California's San Joaquin Valley. (K-3231-17)

should also profit from what's learned there, including irrigators in Oregon, Washington, Nevada, Arizona, New Mexico, and Texas.

Boyle Engineering equipped the subsurface drip plot at Harris' cotton field with five-eighths-inch-diameter black plastic tubing, fitted approximately every 3 feet with drip emitters. A pump pushes water through silica-packed filters, then out through the tubing, which is set 18 inches deep along every other row. In

tomato fields, Harris Farms opted for irrigation tape—flat, pliable hoses that are "cheaper than tubing," according to tomato crop foreman Rafael R. Reyna. "Tape should last about 3 years," he says, "and that's long enough to get our investment back."—
By Marcia Wood, ARS.

Claude J. Phené is with the USDA-ARS Water Management Research Laboratory, 2021 South Peach Avenue, Fresno, CA 93727 (209) 453-3100. ♦

CON KEYES



Surface drip irrigation, used in this cotton field, uses water sparingly yet loses some to evaporation from the soil. (K-3230-18)

Glowing Eggs Speed Screening of Lemons

Pinhead-sized eggs of the Fuller rose beetle, dreaded enemy of citrus, can be made to glow like fireflies. Living eggs emit a stronger glow than dead ones—a distinction that may hasten scientists' efforts to fine-tune new heat or chemical treatments that destroy beetle eggs without harming lemons' taste, texture, or appearance.

The glowing-egg test might also prove useful to agricultural inspectors at packinghouses and ports, says ARS' Louis H. Aung at Fresno, California. The inspectors, Aung says, must be dead certain that lemons shipped from the United States to Japan are free of live eggs.

The test, which relies on luciferin and luciferase—the compounds that give the firefly its flickering light—is not new, but Aung and colleagues at the Horticultural Crops Research Laboratory are the first to come up with the idea of using it to check beetle eggs for signs of life.

"It's a simple, fast, and objective way for us to tell which tactics do the best job killing eggs," Aung says. "We're looking for alternatives to methyl bromide." While the fumigant does the job, an overdose can cause the lemons to discolor.

The female Fuller rose beetle, a greyish-brown, one-third-inch-long weevil, squeezes perhaps six or seven teardrop-shaped eggs into crevices or under the "button"—the calyx where lemon and stem are joined. Eggs hatch into slender white maggots that fall to the ground, feed on roots, and eventually transform into adult beetles that crawl up the tree and eat leaves.

A minor pest in U.S. citrus, the beetle gets its name from one of its favorite meals—rose petals.

Eggs of other unwanted insects—such as the codling moth or navel orangeworm—that attack other crops might also be tested readily for signs of life using the luciferin-luciferase assay.

And the approach might prove similarly useful for occasional checks of beneficial nematodes while they're in

storage. The microscopic, wormlike nematodes have to be kept in a dormant state until dispatched to attack orchard and garden pests such as the navel orangeworm.

The egg scan, developed at Fresno by Aung and Charles F. Forney, Edwin L. Soderstrom, and David G. Brandl, along with James I. Moss (at Orlando, Florida), works like this: A compound called ATP—adenosine triphosphate—is extracted from beetle eggs. The extract is mixed with a few drops of a luciferin-luciferase solution inside a laboratory instrument called a luminometer. When ATP reacts with the solution, it emits a glow. Dead eggs contain much less ATP than live ones, so give a fainter glow.

Even though the reaction occurs "faster than you can blink your eye," says Aung, the luminometer can nevertheless detect and measure it, then report the intensity of the tiny flare on a printout.—By **Marcia Wood**, ARS.

Louis H. Aung is at the USDA-ARS Horticultural Crops Research Laboratory, 2021 S. Peach Ave., Fresno, CA 93727 (209) 453-3000. ♦

Smaller Cows, More Calves in Florida

Fuel economy isn't just for car owners. It can make a big difference in the bottom line for cattle producers, too.

When "fuel"—forage—is scarce, a smaller cow may deliver more calves over the long haul because it needs less nutrition to maintain its own body, according to animal scientist Jorge J. Beltran.

Beltran works at the ARS Subtropical Agricultural Research Station at Brooksville, Florida. There he's recently finished analyzing information from an 8-year study of body size and performance of Angus cows.

"From 1981 to 1989, we studied two lines of cattle—Line A, animals that weighed more at maturity, and Line K, animals that reached maturity faster," Beltran says.

"We found that in this subtropical environment, which is kind of tough for cattle because of inadequate forage, the

reproduction rate for the smaller Line K cows of all ages was 85 percent, compared with 80 percent for the larger Line A cows."

When the cows were checked for pregnancy at 3 years of age, the difference was even greater: 64.9 percent for Line A, compared with 79.2 for Line K.

"Much of this is because, at age 3, these animals are producing milk for their first calf," Beltran notes. "So when feed is short, the larger cows that require more feed to maintain their own bodies simply don't get pregnant again. Those cows are still growing, so the available nutrition goes for that purpose and not for reproduction."

Calves from the larger A cows tended to be larger, averaging 387 pounds at weaning versus the 379-pound weaning weight of calves from K cows.

But the occasional lack of a calf in lean years counts against the larger cows' overall total—and represents lost dollars for the cattle producer who's fed and cared for that cow all year.

"We checked cows born from 1977 to 1985 that were still in the herd in 1988," Beltran says. "These cows had from 1 to 9 years of reproductive performance by 1988, with an average of 3 years."

"For Line A cows, weight totals from the average number of weaned calves came to 950 pounds, compared with 1,072 pounds total from the average number of weaned calves from Line K."

Working with Beltran on the study were geneticists Marvin Koger, Tim A. Olson, and W.T. Butts, Jr. Olson is at the University of Florida Institute of Food and Agricultural Services at Gainesville, Koger has retired from the University, and Butts has retired from ARS' Brooksville station.

"We used Angus for this study because they're a major beef breed in much of this country," Beltran explains. "They're known for high reproduction and good quality of meat."

"But I think this sort of trend in size versus reproduction will be seen in other breeds as well, depending on the environment. Large animals will produce more pounds of calf—and more economically—if there's abundant feed and it's cheap."

"But if feed is not so plentiful, the large cows are so highly demanding for

AGNOTES

their own support that they're at a disadvantage. Even though they wean heavier calves, they sacrifice reproduction in tough years, and they're more likely to skip a year producing a calf."—By **Sandy Miller Hays, ARS.**

Jorge J. Beltran is at the USDA-ARS Subtropical Agricultural Research Station, 22271 Chinsegut Hill Road, Brooksville, FL 34605-0046 (904) 796-3385. ♦

JACK DYKINGA



Plant pathologist Douglas Boyette compares healthy, untreated sicklepod weeds (right) to samples that were treated with *Fusarium oxysporum*. (K-3671-14)

New Weed Weapon Possible

A chance discovery in a Mississippi soybean field may someday lead to a potent new weapon in farmers' biological control arsenal against weeds.

C. Douglas Boyette, an ARS plant pathologist, was almost ready to begin testing a natural pathogen's effectiveness against sicklepod weeds when he noticed nature had started without him.

"We were planting sicklepod for our tests, but there were some sicklepod plants already out there, about 8 inches tall," recalls Boyette. "We hadn't yet made the applications of our pathogen, but I noticed disease on those plants."

Boyette recognized the disease as one he'd seen before, but typically in September and October. This time it was June, "but cool and damp weather, like you'd see in the fall."

Intrigued, he took some of the diseased plant tissue back to the lab and dissected it.

"When we split the stems lengthwise, we could actually see the fungus growing like cobwebs. There were also other fungi on the tissue, but I suspected we had found the key one because it had infected so deeply."

Experts at the University of Minnesota have identified the mystery fungus as *Fusarium oxysporum*, a common wilt pathogen. Boyette says it could prove to be something special for farmers.

"It's not as selective as other pathogens," he notes. "Most pathogens attack only one or two weeds. But this one will attack all sorts of leguminous weeds, including sicklepod, hemp sesbania, and coffee senna."

Controlling just those three would be cause for joy among farmers. Sicklepod plagues soybeans and cotton in the South and Southeast, while coffee senna takes its toll in soybeans and peanuts. Hemp sesbania inflicts havoc in soybeans and rice throughout the Mississippi Delta and is increasingly becoming a problem in cotton as well.

"Farmers spend a lot of money on chemicals to control these three weeds," Boyette says. "And the herbicides can't be used on all crops. For example, the herbicide to control hemp sesbania in rice and soybeans can not be used on cotton plants."

The new pathogen also appears to work over a wide range of soil conditions, Boyette adds.

"It's a soil-borne pathogen, and the soil buffers it from the environmental restraints you face with foliar and stem pathogens," he says. "It doesn't require such a precise environment."

While the pathogen is deadly to some leguminous weeds, greenhouse tests suggest it poses no threat to soybeans, another legume.

"We're also working on a formulation for applying it," he adds. "We hope just one treatment a year, applied at the time you plant your crop, will control these weeds throughout the growing season."

This should be an economical product, too, because it's easy to produce and grows well."—By **Sandy Miller Hays, ARS.**

C. Douglas Boyette is the USDA-ARS Southern Weed Science Laboratory, P.O. Box 350, Stoneville, MS 38776 (601) 686-2311. ♦

Inbreeding May Cause Sheep Losses

In recent years, some articles in sheep trade publications have advocated inbreeding—the practice of mating animals with their relatives. It may boost the frequency of desirable genes, like those for high wool production, if already present in a flock of sheep.

But inbreeding similarly increases the frequency of less desirable genes, which eventually can translate to losses for ranchers, according to results from a 10-year ARS study at the U.S. Sheep Experiment Station in Dubois, Idaho.

In the study, among the largest of its kind, ARS geneticist S. Keith Ercanbrack looked at the effects of inbreeding in three of America's most popular breeds of sheep: Rambouillet, Columbia, and Targhee. He documented 14 different performance traits, ranging from reproductive and lamb survival rates to wool and milk production.

Mating a ram with any of his daughters results in offspring which are 25 percent inbred. If female offspring from that cross then mate with the same ram, their offspring will be even more inbred.

The higher the level of inbreeding, Ercanbrack found, the higher the economic losses; inbreeding reduces reproduction rates, lamb weaning weights, and wool production.

Ercanbrack calculates that ranchers may lose from \$17 to \$36 per ewe, based on current market values for lamb and wool, as inbreeding increases from 20 to 50 percent.—By **Julie Corliss, ARS.**

S. Keith Ercanbrack is at the USDA-ARS Range Sheep Production and Efficiency Research Unit, U.S. Sheep Experiment Station, Dubois, ID 83423 (208) 374-5306. ♦

U.S. Department of Agriculture
Agricultural Research Service
Rm. 318, B-005, BARC-West
10300 Baltimore Ave.
Beltsville, MD 20705-2350

Bulk Rate
Postage and Fees Paid
U.S. Department of Agriculture
Permit No. G-95

Official Business
Penalty for Private Use \$300

To stop mailing ☐

To change your address ☐

Send mailing label on this magazine
and your new address to above
address.

☐ Please send me a year of **Agricultural Research** SN 701-006-00000-3
Charge your order. It's easy!

1. The total cost of my order is \$24.00 (International customers \$30.00) All prices include regular domestic postage and handling and are good through April 1991. After this date, please call Order and Information Desk at 202 783-3238 to verify current price.

2. Please Type or Print

(Company or personal name)

(Additional address/attention line)

(Street address)

(City, State, ZIP Code)

()

(Daytime phone including area code)

3. Please choose method of payment:

- ☐ Check payable to the Superintendent of Documents
☐ GPO Deposit Account
☐ VISA or MasterCard Account

(Credit card account number)

(Credit card expiration date)

(Signature)

4. Mail to: Superintendent of Documents, Government
Printing Office, Washington, DC 20402-9325